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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification 7 :</b> <b>A61K 31/396, 31/351, A61P 35/00, A61K 31/352 // (A61K 31/396, 31:352) (A61K 31/396, 31:351) (A61K 31/352, 31:351) (A61K 31/351, 31:351)</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 00/50032</b> <b>(43) International Publication Date:</b> 31 August 2000 (31.08.00)
<b>(21) International Application Number:</b> PCT/EP00/00745 <b>(22) International Filing Date:</b> 31 January 2000 (31.01.00)  <b>(30) Priority Data:</b> 9904387.9 25 February 1999 (25.02.99) GB  <b>(71) Applicant (for all designated States except US):</b> PHARMACIA & UPJOHN S.P.A. [IT/IT]; Via Robert Koch, 1.2, I-20152 Milan (IT).  <b>(72) Inventors; and</b> <b>(75) Inventors/Applicants (for US only):</b> GERONI, Cristina [IT/IT]; Via Correggio, 48, I-20149 Milan (IT). RIPAMONTI, Marina [IT/IT]; Viale Fulvio Testi, 91, I-20162 Milan (IT). CARUSO, Michele [IT/IT]; Via Desiderio, 3, I-20131 Milan (IT). SUARATO, Antonino [IT/IT]; Via Degli Imbriani, 39, I-20158 Milan (IT).  <b>(74) Common Representative:</b> PHARMACIA & UPJOHN S.P.A.; Viale Pasteur, 10, I-20014 Nerviano (IT).	<b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>	
<b>(54) Title:</b> ANTITUMOUR SYNERGISTIC COMPOSITION  <b>(57) Abstract</b>  There are provided the combined use of 4-demethoxy-3'-deamino-3'-aziridinyl-4'-methansulfonyl daunorubicin or 4-demethoxy-N,N-bis(2-chloroethyl)-4'-methansulfonyl daunorubicin and an antineoplastic topoisomerase II inhibitor in the treatment of tumors and the use of said combination in the treatment or prevention of metastasis or in the treatment of tumors by inhibition of angiogenesis.		

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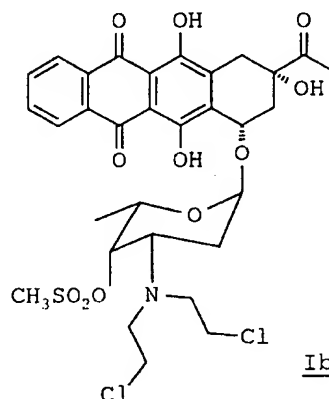
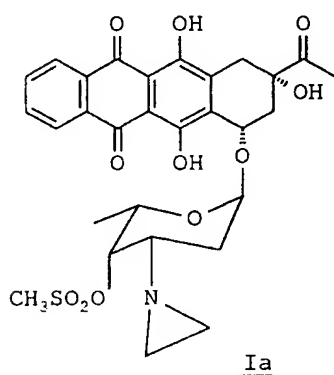
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### Antitumour Synergistic Composition

The present invention relates in general to the field of cancer treatment and, more particularly, provides an antitumor composition comprising an alkylating anthracycline and a topoisomerase II inhibitor, having a synergistic or additive antineoplastic effect.

The present invention provides, in a first aspect, a pharmaceutical composition for use in antineoplastic therapy in mammals, including humans, comprising

- an alkylating anthracycline of formula Ia or Ib :



- an antineoplastic topoisomerase II inhibitor, and a pharmaceutically acceptable carrier or excipient.

The chemical names of the alkylating anthracyclines of formula Ia and Ib are 4-demethoxy-3'-deamino-3'-aziridinyl-4'-methansulfonyl daunorubicin (Ia) and 4-demethoxy-N,N-bis(2-chloroethyl)-4'-methansulfonyl daunorubicin (Ib).

These alkylating anthracyclines were described in Anticancer Drug Design (1995), vol. 10, 641-653, and claimed respectively in US-A-5,532,218 and US-A-5,496,800. Both compounds intercalate into DNA via the chromophore and alkylate guanine at N<sup>7</sup> position in DNA minor groove via their reactive moiety on position 3' of the amino sugar. Compounds Ia and Ib are able to circumvent the resistance

to all major classes of cytotoxics, indicating that the compounds represent a new class of cytotoxic antitumor drugs.

Topoisomerase II inhibitors are described in various scientific publications. The main representatives of this wide class of drugs are: the anthracycline derivatives such as doxorubicin, daunorubicin, epirubicin, nemorubicin and idarubicin; the podophyllotoxin compounds etoposide and teniposide; the anthraquinone derivative like mitoxantrone and amsacrine. See for example the review: Cancer, Principles and Practice of Oncology, Lippincott-Raven Ed. (1997), 452-467. Doxorubicin and etoposide are the preferred topoisomerase II inhibitors to be used in the present invention. The present invention also provides a product comprising an alkylating anthracycline of formula Ia or Ib as defined above and an antineoplastic topoisomerase II inhibitor, as combined preparation for simultaneous, separate or sequential use in antitumor therapy.

A further aspect of the present invention is to provide a method of treating a mammal including humans, suffering from a neoplastic disease state comprising administering to said mammal an alkylating anthracycline of formula Ia or Ib as defined above and an antineoplastic topoisomerase II inhibitor, in amounts effective to produce a synergistic antineoplastic effect.

The present invention also provides a method for lowering the side effects caused by antineoplastic therapy with an antineoplastic agent in mammals, including humans, in need thereof, the method comprising administering to said mammal a combination preparation comprising an antineoplastic topoisomerase II inhibitor as defined above and an alkylating anthracycline of formula Ia or Ib, as defined

above, in amounts effective to produce a synergistic antineoplastic effect.

By the term "a synergistic antineoplastic effect" as used herein is meant the inhibition of the growth tumor, preferably the complete regression of the tumor, administering an effective amount of the combination of an alkylating anthracycline of formula Ia or Ib as defined above and a topoisomerase II inhibitor to mammals, including human.

By the term "administered " or "administering" as used herein is meant parenteral and /or oral administration. By "parenteral" is meant intravenous, subcutaneous and intramuscular administration. In the method of the subject invention, the alkylating anthracycline may be administered simultaneously with the compound with the topoisomerase II inhibitor activity, for example of the anthracycline or etoposide class, or the compounds may be administered sequentially, in either order. It will be appreciated that the actual preferred method and order of administration will vary according to, inter alia, the particular formulation of the alkylating anthracycline of formula Ia or Ib being utilized, the particular formulation of the topoisomerase II inhibitor, such as one of the anthracycline or etoposide class, being utilized, the particular tumor model being treated, and the particular host being treated.

In the method of the subject invention, for the administration of the alkylating anthracycline of formula Ia or Ib, the course of therapy generally employed is from about 0.1 to about 200 mg/m<sup>2</sup> of body surface area. More preferably, the course therapy employed is from about 1 to about 50 mg/m<sup>2</sup> of body surface area.

In the method of the subject invention, for the administration of the topoisomerase II inhibitor the course

of therapy generally employed is from about 1 to about 1000 mg/m<sup>2</sup> of body surface area. More preferably, the course therapy employed is from about 10 to about 500 mg/m<sup>2</sup> of body surface area. The antineoplastic therapy of the present invention is in particular suitable for treating breast, ovary lung, colon, kidney, stomach, pancreas, liver, melanoma, leukemia and brain tumors in mammals, including humans.

In a further aspect, the present invention is directed to the preparation of a pharmaceutical composition containing an effective amount of an alkylating anthracycline of formula Ia or Ib as defined above and an antineoplastic topoisomerase II inhibitor in the prevention or treatment of metastasis or for the treatment of tumors by angiogenesis inhibition, as well as to the use of an alkylating anthracycline of formula Ia or Ib as defined above and an antineoplastic topoisomerase II inhibitor for the treatment of tumors by angiogenesis inhibition or for the treatment or prevention of metastasis .

As stated above, the effect of an alkylating anthracycline of formula Ia or Ib and a topoisomerase II inhibitor, such as an anthracycline or etoposide derivative, is significantly increased without a parallel increased toxicity. In other words, the combined therapy of the present invention enhances the antitumoral effects of the alkylating anthracycline and of the topoisomerase II inhibitor and thus yields the most effective and least toxic treatment for tumors. The superadditive actions of the combination preparation of the present invention are shown for instance by the following *in vivo* tests, which are intended to illustrate but not to limit the present invention.

Table 1 shows the antileukemic activity on disseminated L1210 murine leukemia obtained combining Ia with etoposide.

At the dose of 30 mg/kg of etoposide alone (day +3) and at the dose of 1 mg/kg of Ia alone (days +1,2) were associated, without toxicity, with ILS% values of 100 and 67, respectively. Combining etoposide and Ia at the same doses with the same schedule an increase of activity with ILS% values of 450 was observed, indicating a synergistic effect.

Table 2 shows the antileukemic activity on disseminated L1210 murine leukemia obtained combining Ia with doxorubicin. At the dose of 13 mg/kg of doxorubicin alone (day +3) and at the dose of 1.5 mg/kg of Ia alone (days +1,2) were associated, without toxicity, with ILS% values of 50 and 67, respectively. Combining doxorubicin and Ia at the same doses with the same schedule an increase of activity with ILS% values of 150 was observed, indicating a synergistic effect.

For these experiments Ia was solubilized in [Cremophor®/EtOH= 6.5:3.5]/[normal saline]=20/80 v/v, while standard etoposide pharmaceutical preparation and doxorubicin solubilized in water were used.

Table 1: Antileukemic activity against disseminated L1210<sup>1</sup> murine leukemia of Ia in combination with Etoposide

Compound	Treatment schedule	Dose <sup>2</sup> (mg/kg/day)	ILS% <sup>3</sup>	Tox <sup>4</sup>	LTS <sup>5</sup>
Ia	iv +1,2	1	67	0/10	0/10
Etoposide	iv +3	30	100	0/10	0/10
Ia + Etoposide	iv +1,2 iv +3	1 + 30	450	0/10	4/10

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Table 2: Antileukemic activity against disseminated L1210<sup>1</sup> murine leukemia of Ia in combination with Doxorubicin

Compound	Treatment schedule	Dose <sup>2</sup> (mg/kg/day)	ILS% <sup>3</sup>	Tox <sup>4</sup>	LTS <sup>5</sup>
Ia	iv +1,2	1.5	67	0/10	0/10

Doxorubicin	iv +3	13	50	0/10	0/10
Ia +	iv +1,2	1.5 +	150	0/10	3/10
Doxorubicin	iv +3	13			

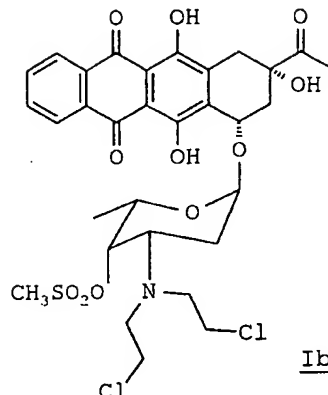
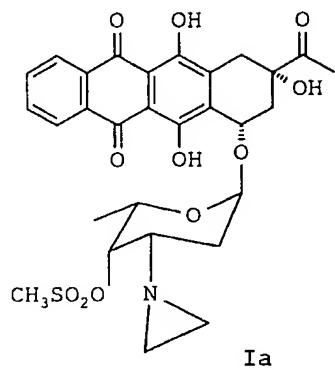
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- 1) L1210 leukemia cells ( $10^5$ /mouse) are injected iv on day 0.
  - 2) Treatment is given starting on day 1 after tumor transplantation (day 0).
- 10
- 3) Increase in life span:  $[(\text{median survival time of treated mice} / \text{median survival time of controls}) \times 100] - 100$
  - 4) Number of toxic deaths/number of mice.
  - 5) Long Term Survivors (>60 days) at the end the experiment.



## Claims

1. Products containing an alkylating anthracycline of formula Ia or Ib:

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and an antineoplastic topoisomerase II inhibitor as a combined preparation for simultaneous, separate or sequential use in the treatment of tumors.

10 2. Products according to claim 1 wherein the alkylating anthracycline is 4-demethoxy-3'-deamino-3'-aziridinyl-4'-methansulfonyl daunorubicin.

3. Products according to claim 1 or 2 wherein the topoisomerase II inhibitor is etoposide.

15 4. Products according to claim 1 or 2 wherein the topoisomerase II inhibitor is doxorubicin.

5. A pharmaceutical composition comprising a pharmaceutically acceptable carrier or excipient and, as active ingredient, an alkylating anthracycline of formula  
20 Ia or Ib as defined in claim 1 and an antineoplastic topoisomerase II inhibitor.

6. A composition according to claim 5 wherein the topoisomerase II inhibitor is doxorubicin or etoposide.

7. Use of an alkylating anthracycline of formula Ia or Ib  
25 as defined in claim 1 and an antineoplastic topoisomerase

II inhibitor in the preparation of a medicament for use in the treatment of tumors.

8. Use according to claim 7 wherein the topoisomerase II inhibitor is etoposide or doxorubicin.

- 5 9. Use of an alkylating anthracycline of formula Ia or Ib as defined in claim 1 and an antineoplastic topoisomerase II inhibitor in the preparation of a medicament for use in the prevention or treatment of metastasis or in the treatment of tumors by inhibition of angiogenesis.

# INTERNATIONAL SEARCH REPORT

Int. J. Application No

PCT/EP 00/00745

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 A61K31/396 A61K31/351 A61P35/00 A61K31/352  
 //(A61K31/396,31:352),(A61K31/396,31:351),(A61K31/352,31:351),  
 (A61K31/351,31:351)

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 A61K A61P

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO 99 48503 A (CARUSO MICHELE ;GERONI CRISTINA (IT); PHARMACIA & UPJOHN SPA (IT);) 30 September 1999 (1999-09-30) claims 1-7	1-9
Y	EDER JP ET AL: "Sequence effect of irinotecan (CPT-11) and topoisomerase II inhibitors in vivo" CANCER CHEMOTHERAPY AND PHARMACOLOGY,DE,SPRINGER VERLAG, BERLIN, vol. 42, no. 4, 1998, pages 327-335, XP002112007 ISSN: 0344-5704 abstract page 334	1-9

☒ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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12 May 2000

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 5 532 218 A (BARGIOTTI ALBERTO ET AL) 2 July 1996 (1996-07-02) cited in the application claims 1,6,10	1-9
Y	US 5 496 808 A (BARGIOTTI ALBERTO ET AL) 5 March 1996 (1996-03-05) cited in the application claims 1,2,29	1-9

# INTERNATIONAL SEARCH REPORT

Information on patent family members

Int. J. Appl. No.

PCT/EP 00/00745

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9948503 A	30-09-1999	AU 3331499 A	18-10-1999
US 5532218 A	02-07-1996	AT 157369 T	15-09-1997
		AU 676625 B	13-03-1997
		AU 1066095 A	03-07-1995
		CA 2154890 A	22-06-1995
		CN 1117734 A,B	28-02-1996
		DE 69405214 D	02-10-1997
		DE 69405214 T	29-01-1998
		DK 683788 T	27-10-1997
		WO 9516695 A	22-06-1995
		EP 0683788 A	29-11-1995
		ES 2107294 T	16-11-1997
		FI 953784 A	09-08-1995
		GR 3025266 T	27-02-1998
		HU 73172 A	28-06-1996
		IL 111725 A	15-07-1998
		JP 8506835 T	23-07-1996
		NO 953163 A	02-10-1995
		NZ 276401 A	24-10-1997
		PL 310177 A	27-11-1995
		ZA 9409701 A	12-12-1995
US 5496808 A	05-03-1996	AT 134376 T	15-03-1996
		AU 661012 B	13-07-1995
		AU 2229492 A	11-02-1993
		CA 2112818 A	21-01-1993
		CN 1069981 A,B	17-03-1993
		CZ 9400024 A	13-07-1994
		DE 69208400 D	28-03-1996
		DE 69208400 T	27-06-1996
		DK 521458 T	18-03-1996
		WO 9301201 A	21-01-1993
		EP 0521458 A	07-01-1993
		FI 940011 A	03-01-1994
		GR 3019429 T	30-06-1996
		HK 1006460 A	26-02-1999
		HU 70480 A	30-10-1995
		IE 76921 B	05-11-1997
		IL 102409 A	08-12-1995
		JP 6508841 T	06-10-1994
		MX 9203928 A	01-04-1993
		NO 940026 A	16-02-1994
		NZ 243450 A	25-11-1993
		ZA 9204971 A	31-03-1993